DORSAL SPOT PATTERN AS UNIQUE MARKERS TO ESTIMATE THE POPULATION SIZE OF *RANA CURTIPES*[1]

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Marking animals with unique marks is necessary for estimating population densities when using the Capture-Recapture Method. The dorsal spot pattern method to identify individuals is considered best for such studies, as it does not cause any physical injury to the animal. Dorsal spot pattern in the bicoloured frog, *Rana curtipes* is shown to be an appropriate method to identify individuals. While studying the population size and density of *Rana curtipes* in the Western Ghats we identified 160 frogs in the Western Ghats of Karnataka by the spot patterns on their dorsum. An identification catalogue, based on the total spot count, spotting patterns and size was prepared for each individual.

Key words: *Rana curtipes*, marking, capture-recapture, photo identification, Western Ghats

Many ecological studies of animals, including population studies, space-use patterns or growth rates, depend on individual-specific marks. Several external marking techniques, like paint, PIT tags and tattoos for reptiles, jaw tagging and dye markers for fishes, leg ring for birds and toe clipping for small mammals (Donnelly *et al.* 1994), have been employed to identify individuals. All these marking techniques involve capture and handling of the animals. Some of the markings are permanent or long lasting, while some are short-lived. Unique natural markings have also been used for studies by a few ecologists. In large mammals like the Tiger, the unique stripe patterns, photographed using camera traps, were used as markers (Karanth 1995). Carlstrom and Edelstram (1946) used photographs of colour patterns on the ventral scales of grass snakes, the throat of slow worms and the dorsum of some lizards, to identify them following recapture. Henley (1981) saved portions of shed skins of study snakes that included unique features, and attached these to the specimen's data card for identifying it later. Shine *et al.* (1988) noted the number and relative position of divided subcaudal scales to identify individual snakes. McDonald *et al.* (1996) used the unique appearance of the pineal spot, or "pink spot", on the top of the head of Leatherback Sea Turtles to recognise individuals. Singh and Bustard (1976) recorded the pattern of pigmented bands and blotches on the tails of hatchling gharials to identify a large number of juveniles in captivity.

Some different types of tags used to mark amphibians are fluorescent pigments, toe clipping, tattooing and PIT tags. Loafman (1991) reports a method of identifying spotted salamander individuals by spot patterns. He describes each animal's pattern as the spots found on head, neck, and body and limbs. The natural variation in belly pattern of the newt *Urodella triturus* has been used to make a catalogue of photographs from which identification of an individual is possible (Sutherland 2000).

While estimating the population size of the free ranging ranid frog *R. curtipes* in the tropical rainforests of the Western Ghats, we identified 160 individuals, by the spots on its dorsum. *Rana curtipes* is an inhabitant of leaf litter and is endemic to the Western Ghats of peninsular Indian states of Karnataka, Kerala, Tamil Nadu and southern Madhya Pradesh (Inger and Dutta 1986; Daniels 1997). Literature on the distribution (Dutta 1992), reproduction (Krishnamurthy and Shakunthala 1997) and hormonal studies of the larva (Varamparampil and Oommen 1997) of this frog are available. However, none of these studies have either used natural pattern mapping to identify individuals or recorded the population status of the species.

METHODS

We studied the population biology of this species in the Bisale Reserve Forest adjoining the Coorg hills, 12° 15' N and 76° 33' E, Karnataka State, India. The study sites were located on the western slopes of the Western Ghats, ranging from 350-860 m above msl. The area is a tropical rainforest (annual average rainfall 5,500 mm) with dense canopy cover and many perennial hill streams. The study was conducted from January 1999 to July 2001.

Rana curtipes are forest frogs, feeding on low flying and crawling insects. They are bicoloured, with olive-golden yellow back, and uniformly black sides, limbs and belly (Daniels 1997). The dorsal side of the frog exhibits colour polymorphism; a majority of them were reddish-yellow and a few had an ashy grey back. Irrespective of the background,

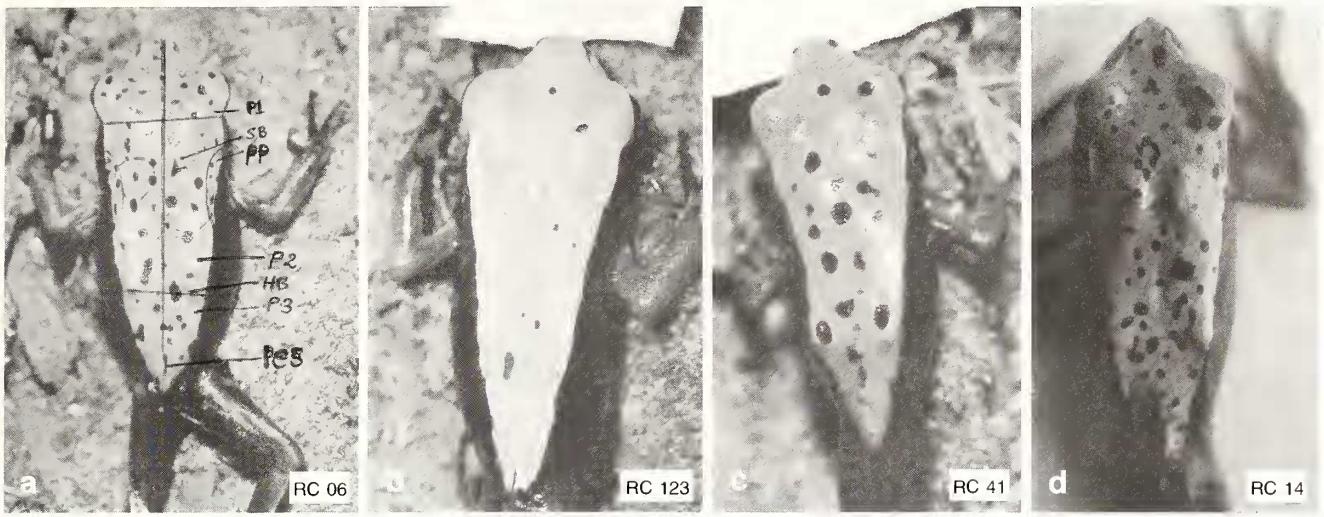

Fig. 1: Some examples from the photo catalogue depicting the unique dorsal spot patterns of *Rana curtipes* and their unique ID numbers a. Rc 06, b. Rc 123, c. Rc 41, d. Rc 14
P1, part 1; P2, part 2; P3, part 3; PP, parotid patch; SB, Shoulder bone; HB, hipbone; PCS posterior central spot

the dorsal side had numerous black spots with considerable variation in spot frequencies, size, location and designs. A reddish parotid patch may be visible. In breeding pairs the spots were less pronounced, but we did not observe any correlation of spot number or size to the overall size of the frog. The newly emerged frog ranged from 15-18 mm snout to vent length (SVL) (mean SVL 16.5 mm; N=94) and the breeding adults grew to 68.5 mm SVL (N=38).

In general, the dorsal side is marked with black, irregularly shaped spots on an ashy grey or reddish-yellow background (Fig. 1). The total number of spots and the pattern in which they are spread is different in each individual. Based on the total spot count, size and unique spotting patterns, we prepared an identification catalogue for each individual. To make a unique ID for each individual, we divided the dorsum into three parts: P1, P2, P3 (Fig. 1).

Individuals were classified as having high (50 and above), moderate (>20 but <50), low (>10 but <20) or very low (<10) spot count depending on the total count of spots from snout to vent. Once classified, the number of spots in each region, namely P1, P2 and P3 were counted. Some individuals with unique patterns on the back were also noted. The presence or absence of the posterior central spot (PCS) and parotid patch (PP) was noted. The information was tabulated as "spot pattern ID catalogue" (Table 1). On the capture of a frog, its SVL and other dorsal spot pattern data were recorded as per Table 1. An individual identification number was recorded in the first column.

The dorsum of each individual captured was photographed using a Nikon F90X camera with flash and AF Nikkor 105 mm 1:2.8 D lens to get a shadow-free colour picture. A photo identification catalogue of all the 160 frogs sampled in the field was made. All the sampled frogs were released immediately at the site of capture.

These patterns were found to be unique and helped to identify individual frogs. The photo catalogue and spot pattern catalogue was used to identify captured frogs. As the dorsal spot pattern method is reliable and painless compared to other methods, we used it to mark *R. curtipes* to estimate their population size, using capture-recapture method. It was noted that no two frogs captured were identical in the spot pattern nor did the pattern change during the course of this study.

As *Rana curtipes* is a forest floor species, the Quadrat Sampling Method was thought to be more appropriate for quantitative analysis. Frogs were sampled within 8 x 8 m random quadrates within the study area and sampled on 5 occasions. Capture-recapture history was recorded.

RESULTS AND DISCUSSION

Using Petersen Estimate (Bailey's modification), the population size of *R. curtipes* during 1999-2000 was estimated to be 272.33 individuals (standard error 10.97) with a density of 0.08 to 0.1 (N=22 quadrates) frogs per square metre.

The use of natural markings as a means of identification is advantageous as there is no physical injury to the animal. It saves the animal from the stress of capture, marking and handling. While we used this method of photo catalogue, we observed that neither did the normal behaviour of the animal change, nor did the survival rate alter.

Table 1: Dorsal spot pattern catalogue for *Rana curtipes* sampled in the Western Ghats of Karnataka

ID No.	SVL	PP	Total	P1	P2	P3	Notable spot pattern on the back	Posterior central spot (PCS)
Rc06	50.20	+	High	16	30	9	A circle of five spots with a central spot on the right eyelid. On the left shoulder and right shoulder of P2, two circles of six spots with a central dot. An elongated spot touching the left hipbone	Elongated like a comma, but not touching the vent
Rc41	37.42	-	Low	2	14	2	A round spot on the intraorbital region and on the right eyelid. Circle of seven spots with a central spot in the middle of P2, one spot among the seven is key shaped. At the end of P2, three spots (one on each hipbone) forming a triangle if joined	Absent
Rc09	50.30	+	Moderate	4	24	13	A spot on the centre of left eyelid and one at intraorbital region. Two prominent spots on the anterior end of the shoulder bone with a central dot between the two bones. On the right side of P2 "(" marking	Central elongated spot touches the vent and also looks more longer due to the joining of two more spots. "Y" at the vent
Rc14	52.55	-	High	23	39	18	A 3 mm oval spot on the snout, a circle of 4 spots on the right eyelid. A circle due to the joining of 7 spots just before the left shoulder, on the mid right side of the frog a big squarish spot (5 mm), "()" mark on the right hipbone	Elongated touching the vent
Rc123	55.41	-	Very low	2	5	2	A tadpole shaped mark on the anterior of left hipbone	Faint, touching the vent

Note: Only five individuals have been listed as examples in the table

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